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# Future Combat Model

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# Outline

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- Motivation
- Discriminating Capability
- Unique Approach That Fills a Gap

# Motivation

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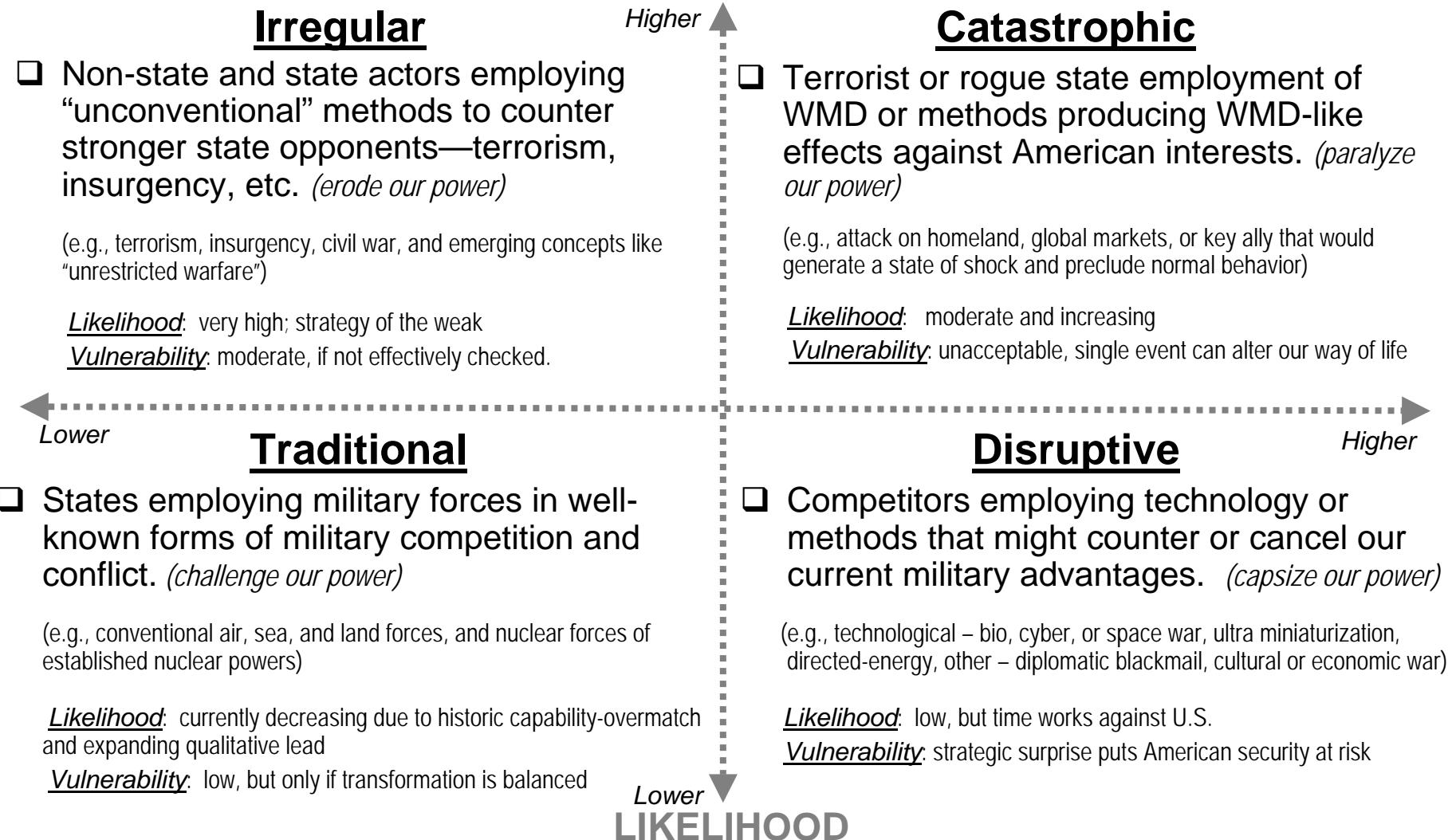
- Changing geopolitical and operational environment
- Increasing importance of C4ISR to military effectiveness
- Capabilities based analysis and use of non-traditional scenarios
- Continued problems modeling C4ISR

# Changing Environment

- **Operations: Getting beyond Force-on-Force Operations to...**
  - Asymmetric Warfare by State and Non-State Actors
  - Network-Centric Operations
  - Effects-Based Operations
  - Information Operations
- **Information: Essential reliance on C4ISR**
  - Information Superiority
  - Real-Time Precision Strike
  - Dominant Battlefield Awareness
  - Sensor-to-Target
  - Perception-based decisions and implications of inaccuracies
  - Winning the fight by preventing the fight
- **Resource Planning: Breaking the Ops-Intel barrier to synchronize resourcing**
  - Demand for multi-scenario planning and sequencing
  - Capability-Based Planning

# Capabilities Based Planning Paradigm

VULNERABILITY



**Capabilities-based planning should apportion risk across challenges**

Source: OSD/Policy

# The Imperative For Improvement

## Current

Force on Force  
Attrition Based  
Individual Systems  
Shooter to Target  
Target-Weapon centric  
Single scenario, focused Ops  
Symmetric, near-peer combat  
Limited treatment of C4ISR  
Model based  
Ignore pre crisis phases  
Complex, attrition based

## Needed

Information on Information  
Effects Based  
Families of Systems  
Sensor to shooter to target  
Decision Cycle centric  
Multiple scenarios, broad spectrum of Ops  
Asymmetric operations  
Driven by information dominance  
Analysis based  
Driven by pre-crisis developments  
Flexible, effects based

Analysts & Models are losing touch with the needs of the warfighter

# FCM Version 1.0

- ✓ Explicitly models the “Road to War”
- ✓ Effects Based Planning & Operations using target/effects networks
- ✓ Hierarchical & Reactive Command & Control
  - Perception (2-way) based planning
  - Flexible Geographic Representation
  - Innovative aggregation and abstraction supplement high value entity modeling to facilitate fast run-time and improved operational realism
  - Fast run-time facilitates:
    - Quick turnaround analyses using parametric sensitivity approach
    - Fast model customization, testing, and VV&A cycles
    - Compressed analyst/decision maker feedback loop
  - Stochastic, Deterministic, and Mixed modes
    - Deterministic mode allows for rapid run time & large exploratory experiments
    - Stochastic modes allow for estimation of variation and risks associated with C4ISR/operational decision making and other high leverage processes
    - Focuses use of stochastic modeling on high leverage areas (perception, planning, allocation)

# Illustrative Scenario

## **Red Objectives:**

- Control Straits of Taiwan
- Utilize mining of key facilities
- Position surface ships to protect forces crossing straits
- Protect forces with long range SAMs
- Utilize SOF assets to capture critical nodes and arcs
- Begin invasion with surface-to-surface missile strikes
  - Destroy enemy command and control system;
  - Cripple enemy information systems;
  - Destroy enemy's most advanced weapons systems;
  - Cripple enemy logistics systems

## **Blue Objectives:**

- Defend Taiwan from invasion by mainland Chinese forces
- If deterrence fails, defeat attacking forces and secure long-term security of island

## **Limitations**

- Force structure
- Basing

## **Response**

- US deploys forces and conducts offensive operations in support of Taiwanese military

## **Key to success**

- Adequate indications and warning which allows timely deployment of forces



# Red Campaign Plan

- **Phase 1:**

- Prepare 35 Divisions (5 Heavy, 15 Medium, 15 Light) for movement to SPODS for transhipment by sea-going transports

- **Phase 2:**

- Move Heavy Divisions by rail to SPODS
- Prepare and position IADS, and TBM Brigades in operational locations.
- Prepare and position attack and DCA air forces in operational locations

- **Phase 3:**

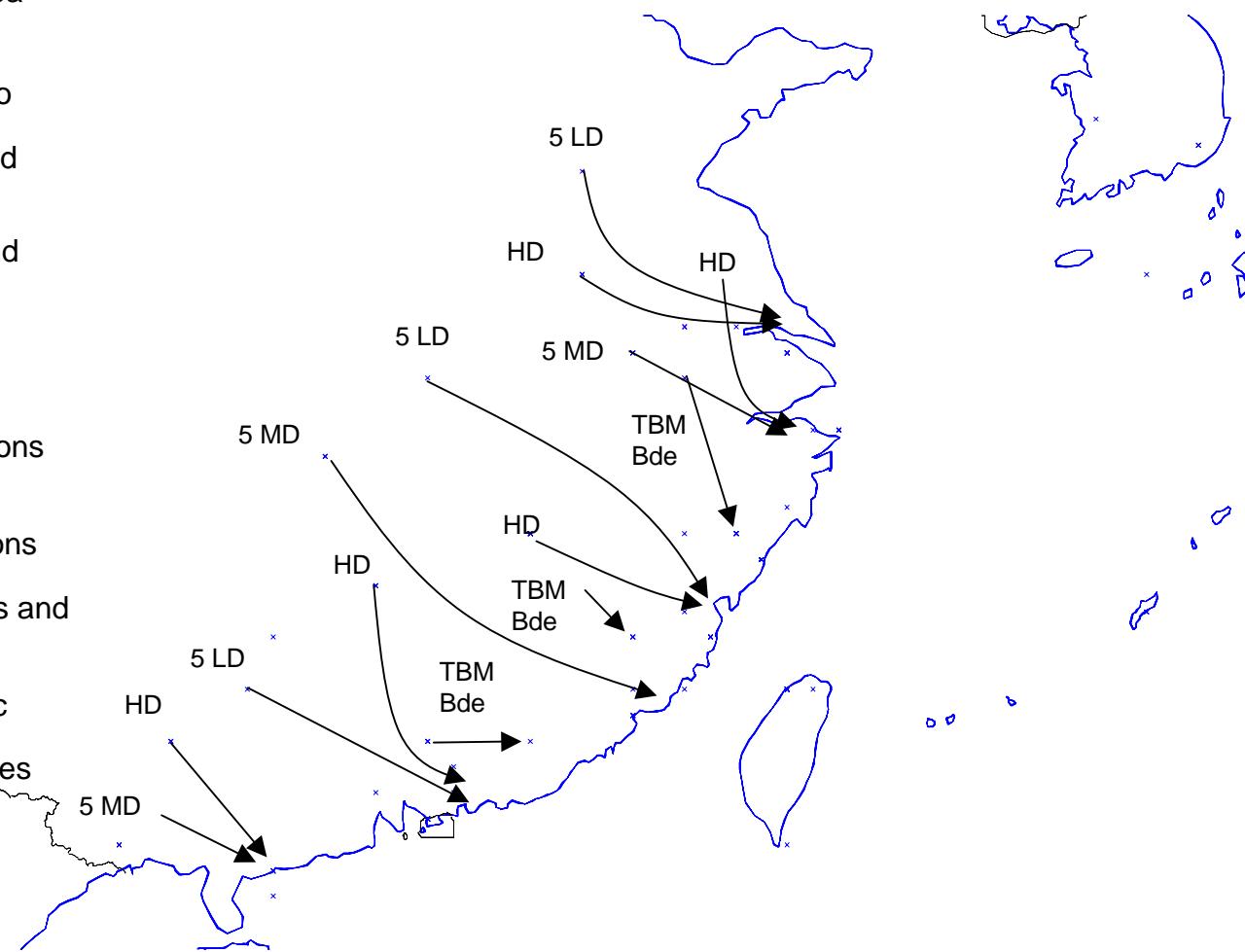
- Load Heavy Divisions onto transports
- Move Medium and Light Divisions by rail to SPODS

- **Phase 4:**

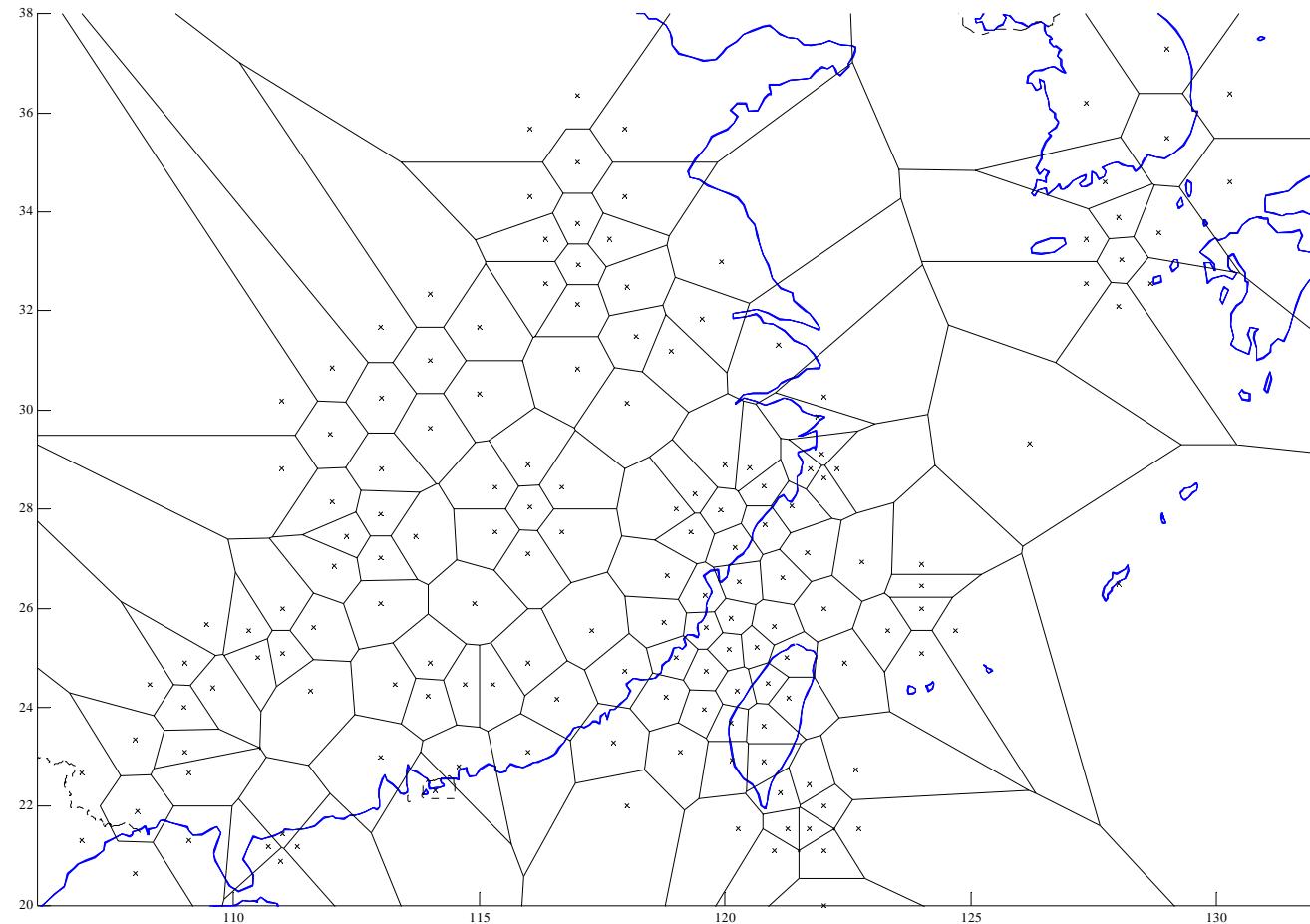
- Load Medium and Light Divisions onto transports
- Sortie transports, surface ships and submarines

- **Phase 5:**

- Launch TBMs against strategic targets
- Begin assault with SOF, Marines and Army Divisions



# Variable Geographic Representation



# C2 & “Stages”

- **Each side attempts to meet operational objectives by completing a side specific set of operational “stage orders”**
  - Stages are a set of operational orders to create operational effects and achieve desired force distributions
- **Stages are defined for pre-combat and combat phases**
  - Pre-combat stages are designed to achieve desired force positioning objectives
  - Combat stages are designed to achieve campaign objectives
  - Stages can be proactive or reactive
- **Stage progression is based on perceptions of stage progress for self and opponent**
  - Stages can be skipped
  - Stage transitions can be triggered by perception of opponent’s change in stage
- **A stage is completed when:**
  - A pre-defined fraction of asset distribution goals are met
  - Operational effects goals are met
- **Stage transition matrix**
  - Defines next stage to achieve based on own side’s current stage achieved and perceived opponent’s stage

# Stage Definitions

Red Stages		Tgt Set	Airbase	SPOD	IADS	TBM Bde	Hvy Div	Med Div	Marine Div	Army Lt Div	Marine Lt Div	SubRon	DesRon	FPhibRon	FTranRon
	#		5	6	3	3	5	14	1	14	1	6	6	6	6
	Day														
0	Peace	0													
1	Mob/Prep	10					Prep								
2	Initial Mob	25	Prep		Prep		Load	Prep							
3	Disperse AC	30			Deploy		Move	Load							
4	Rockets	33	Operate			Prep		Move	Prep	Prep	Prep			Prep	
5	Amphibs	38				Deploy		Rollo	Move	Move	Move	Move	Move	Load	
6	Sortie								Load & Go	Load & Go	Load & Go			Sea	Sea
7	Amphibs	45				Refuel	Sea	Sea							
7	H Hour	47			Defend	Attack								Landing	
8	Quick Attack	45			Defend	Attack	Sea	Sea	Sea	Sea	Sea			Landing	
9	Amphibious						Land	Land	Land	Land	Land				
9	Assault	48													Landing

Blue Stages	Stage Name	Order
10	Peace	
11	Exercise Reaction	Increase ISR, move "local" CVSG to Taiwan (~3 days), alert & deploy Taiwanese forces
12	Ambiguous Warning	14+Move 2nd CVSG from Hawaii to Taiwan (~10 days), move 3rd CVSG from IO to Taiwan (~10 days)
13	Less Ambiguous Warning	15+Fly air defense caps from Japan/Korea to Taiwan, deploy B-1s and B-52s to Guam, alert rapid reaction forces (e.g. MEF & 82nd AB)
14	Unambiguous Warning	16+Deploy fighters, AWACS, etc to Japan/Korea; deploy Patriots & AA fighters to Taiwan; deploy rapid reaction forces to Taiwan; call up reserves, start mobilization of forces to theater (e.g. Japan/Korea/Taiwan)
15	Defend	17+Defend Taiwan with available forces (AA fighters, Patriots), attack Chinese ships at sea, attack Chinese IADS, C2, SPODs, APODs

# Red Stage Transition Matrix

Blue Stage	10 Peace	11 Exercise Reaction	12 Ambiguous Warning	13 Less Ambiguous Warning	14 Unambiguous Warning	15 Active Defense
Red Stage						
0 - Peace	1	1	1	0	0	0
1 - MOB/Prep	2	2	2	2	2	0
2 - Initial MOB	3	3	3	3	3	1
3 - Disperse AC	4	4	4	4	4	2
4 - Prep Rockets	5	5	5	5	5	3
5 - Load Amphibs	6	6	6	6	6	4
6 - Sortie Amphibs	7	7	7	7	8	5
7 - H Hour	9	9	9	9	9	9
8 - Quick Attack	9	9	9	9	9	9
9 - Landing	9	9	9	9	9	9

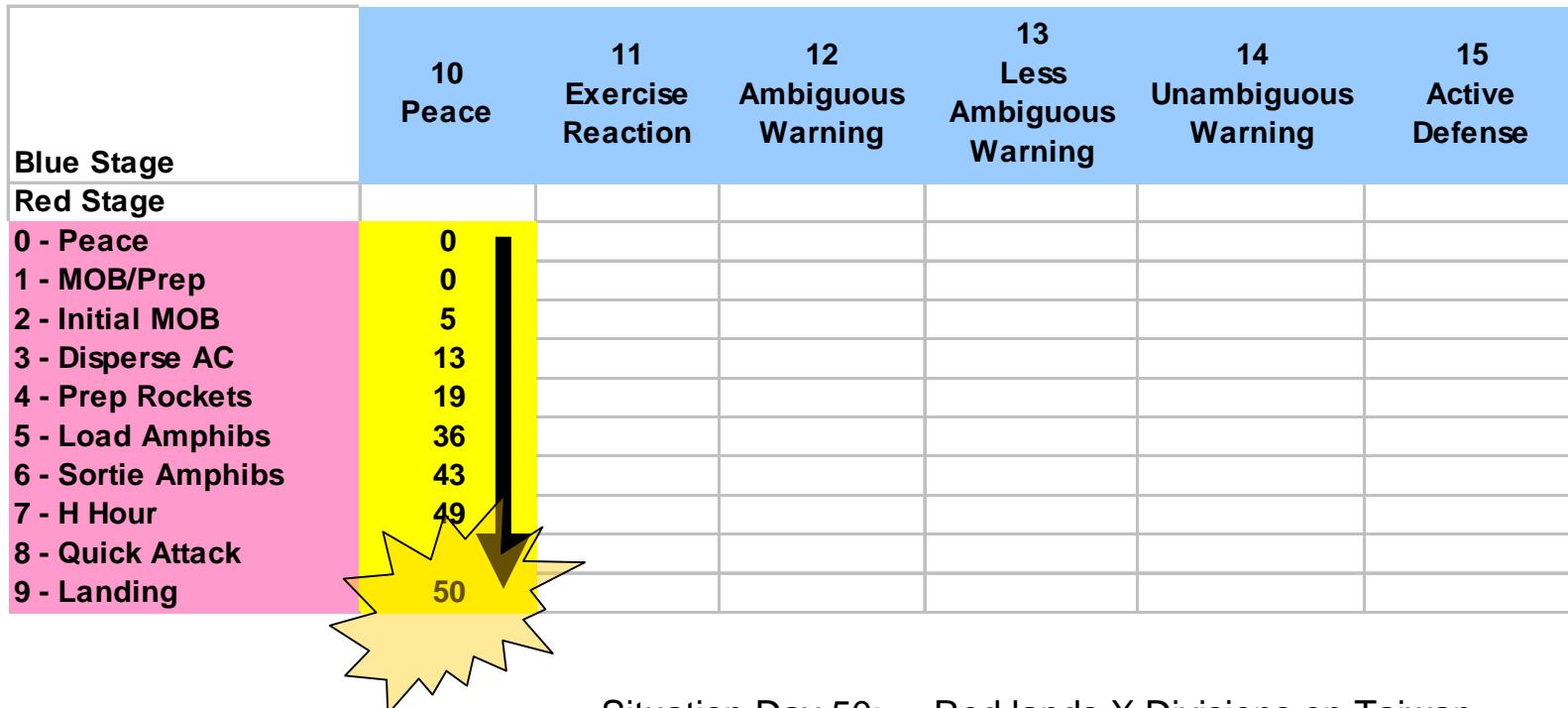
Note: Entries in stage transition matrix indicate “Red stage ordered” based on Red’s perception of Red and Blue current stages.

# Blue Reaction Orders

Blue Stage	10 Peace	11 Exercise Reaction	12 Ambiguous Warning	13 Less Ambiguous Warning	14 Unambiguous Warning	15 Active Defense
Red Stage						
0 - Peace	10	10	10	10	10	10
1 - MOB/Prep	11	11	11	11	11	11
2 - Initial MOB	11	11	11	11	11	11
3 - Disperse AC	12	12	12	12	12	12
4 - Prep Rockets	13	13	13	13	13	13
5 - Load Amphibs	14	14	14	14	14	14
6 - Sortie Amphibs	14	14	14	14	14	14
7 - H Hour	15	15	15	15	15	15
8 - Quick Attack	15	15	15	15	15	15
9 - Landing	15	15	15	15	15	15

Note: Entries in stage transition matrix indicate “Blue stage ordered” based on Blue’s perception of Red and Blue current stages.

# Red Objective Timeline



Situation Day 50: Red lands X Divisions on Taiwan  
 Blue remains in a peacetime posture, i.e.  
 carrier strike groups, bombers & fighters  
 are not deployed

Red's objective is to advance to stage 9 as soon as possible.

# Blue Desired Reaction Timeline



Situation Day 37: Blue has completed deployment of carriers, bombers, fighters, etc to the theater.  
Red backs down and cancels planned invasion

Blue's objective is to achieve unambiguous warning in sufficient time to deter aggression.

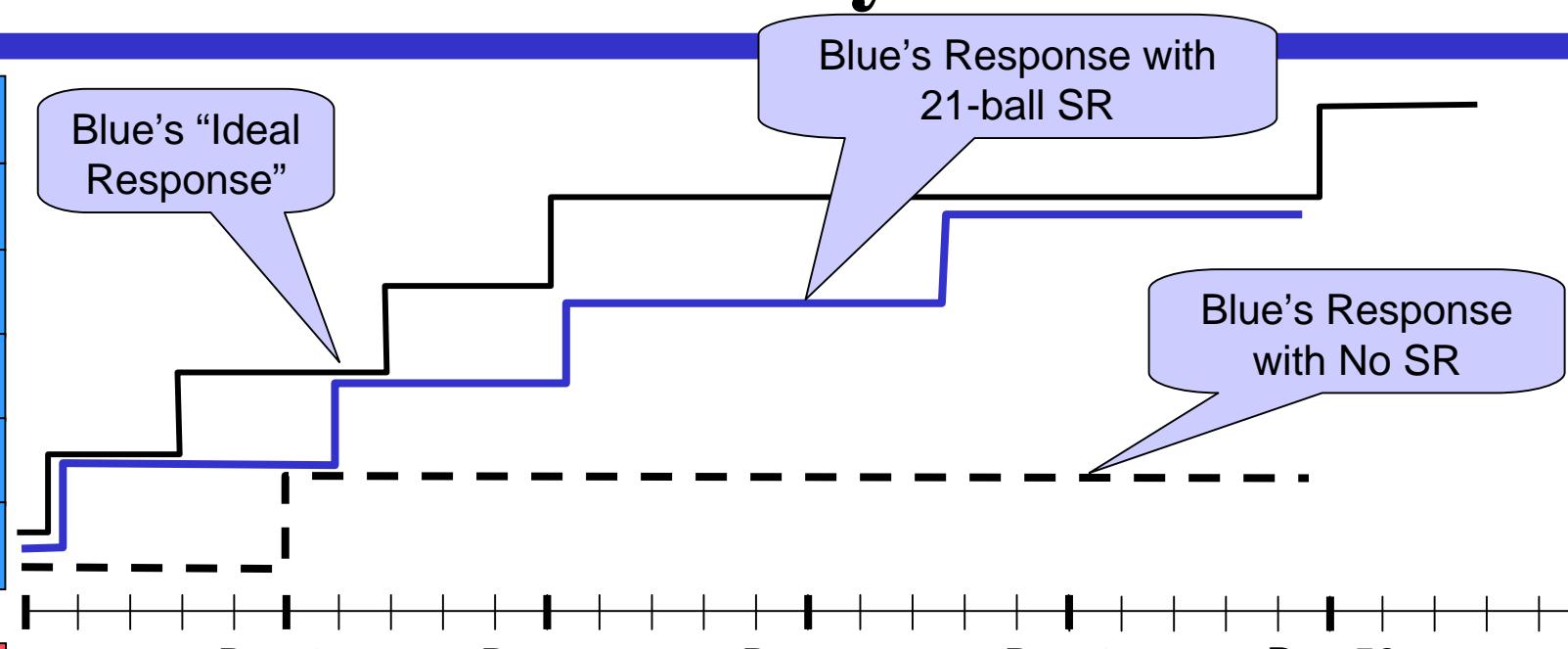
# Stage Perception

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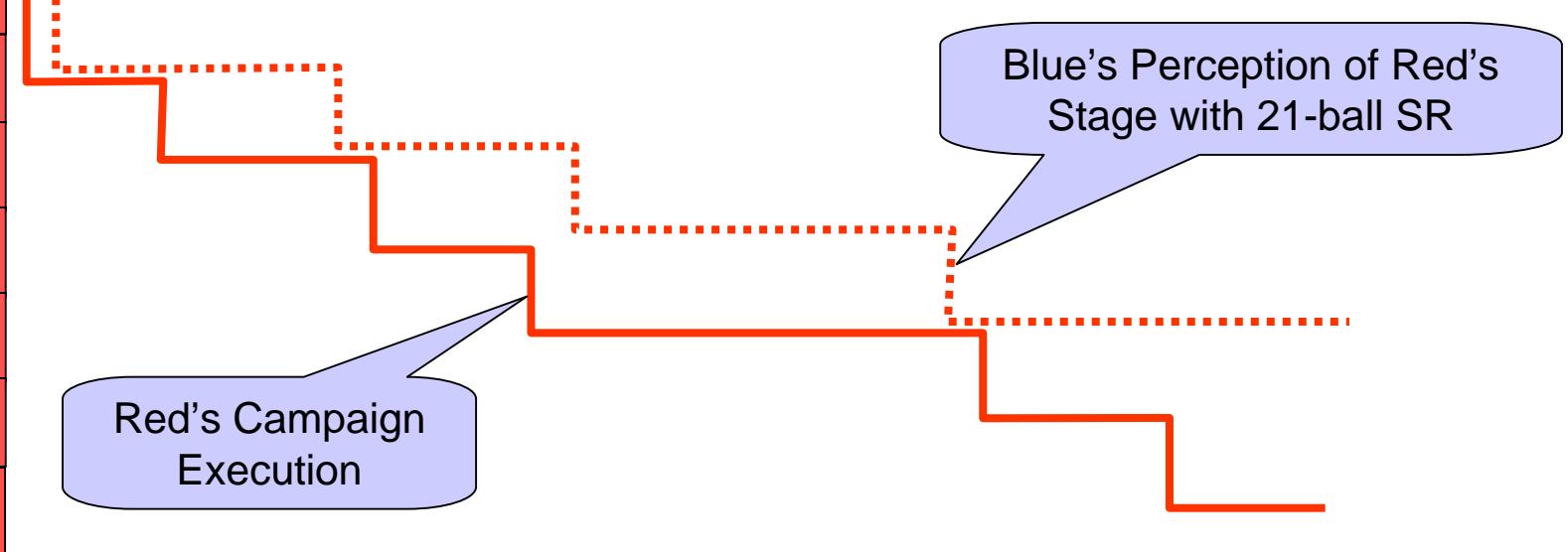
- Perceptions of opponent stage conditions is driven by ISR-based observables and a Bayesian Stage Perception Model
- Observations of opponent force distributions (by cell), opponent force movement activity (within cell), and opponent effects based operations are used to determine likelihood of current stages and subsequent stages.

# Illustrative Study Result

15: Active Defense
14: Unambig Warning
13 – Less Ambig Warning
12 - Ambiguous Warning
11 – Exercise Reaction
10 - Peace



0 –Peace
1 – Mob/Prep
2 – Initial Mob
3 – Disperse AC
4 – Prep Rx
5 – Load Amphibs
6 – Sortie Amphibs



# Summary

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- **FCM is being developed to analyze C4ISR contributions across a wide range of combat scenarios**
- **FCM is designed to incorporate:**
  - Effects Based Operations, Joint Functional Concepts and Joint Integrating Concepts
- **FCM is designed to support analyses that are responsive to decision demands and timelines**
- **FCM IOC Sept '05**

# Sensor Access Approach

- Access times will vary from hour to hour and from day to day based on pre-computed constellation simulation results (STK)
- Access times may vary from cell to cell depending on size of the region
- Multiple accesses to a cell will increase total access time in a cell; i.e. access time for an hour can exceed 60 minutes
- Simple rules of thumb are used to calculate imaging time from total access
  - For Space RADAR, SAR access will be derived from SMTI access, e.g. SAR access time =  $.7 * \text{SMTI access time}$
  - For space-based IMINT systems, medium and high quality time will be calculated based on low quality time, e.g. High Quality access time =  $.7 * \text{Low Quality access time}$

# ISR Resource Availability

- **Utilization fraction reduces access time over theater of interest**
- **Utilization fraction represents**
  - Arrival of assets for use in theater
  - Tasking on ISR assets related to out of theater priorities
- **In-theater national tasking can be handled with explicit “background” requirements**

ISR Asset	Stage 13	Stage 14	Stage 15	Stage 16	Stage 17
	Peacetime	Exercise	Ambiguous Warning	Less Ambiguous Warning	Unambiguous Warning
Space Based Radar	0.6	0.7	0.8	0.8	0.9
Advanced Commercial Imagery	0.6	0.6	0.7	0.7	0.9
JSTARS	0.0	0.0	0.0	1.0	1.0
Global Hawk	0.0	0.0	0.0	0.0	1.0

ISR Availability Table

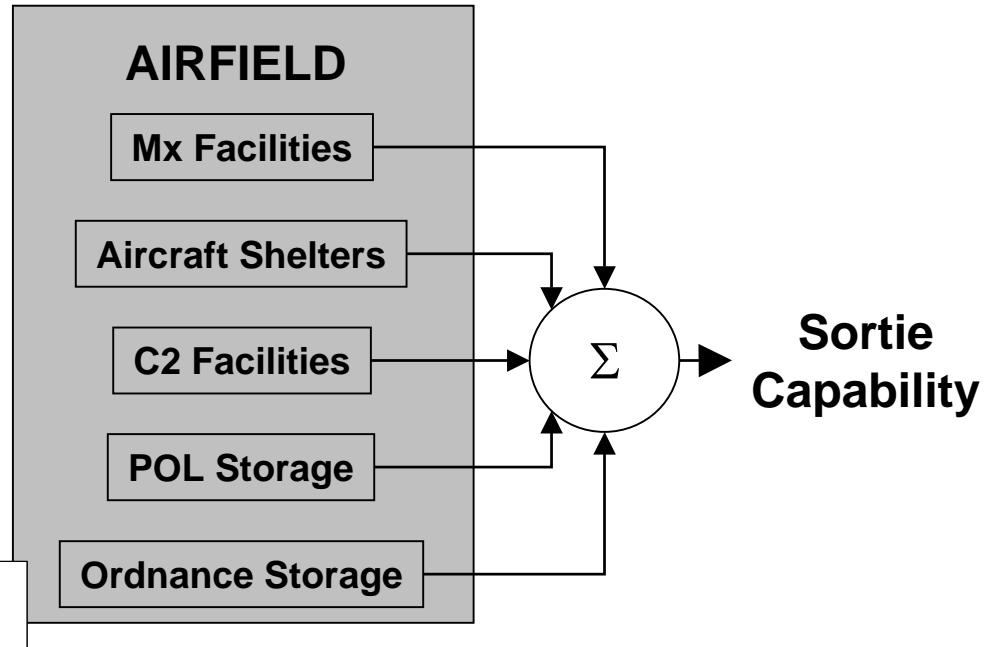
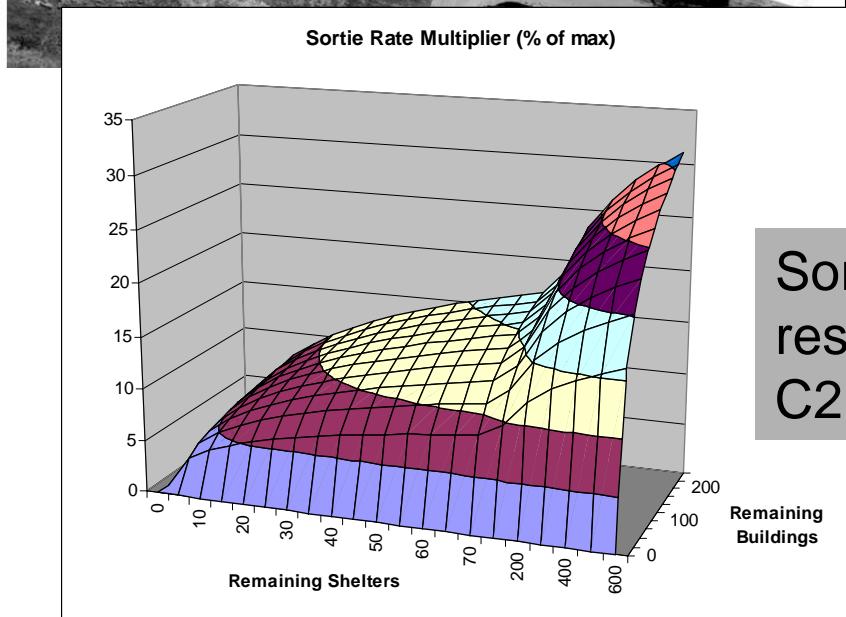
# Red “Target Sets”

# Effects Based Operations

- **Campaign planning will be based on generating “effects” which are based on the interactions among targets.**
  - Attrition based planning is driven by a desired number of targets killed
  - Effects based planning is driven by a goal of reducing operational capabilities of operational systems by destroying elements of that system
- **“Functional Asset Sets” and capability metrics**

– Airbase	Maximum Sortie Rate
– Carrier Strike Group	Maximum Sortie Rate
– Integrated Air Defense Set	Maximum Engagement Rate
– SSM Brigade	Maximum Launch Rate
– C2 Set	C2 latency
– S&R Set	S&R capacity/timeliness
– Gnd Unit of Action	Combat Effectiveness
– Logistics Set capacity	Units supported per day, APOD/SPOD

# Effects-Based Operations

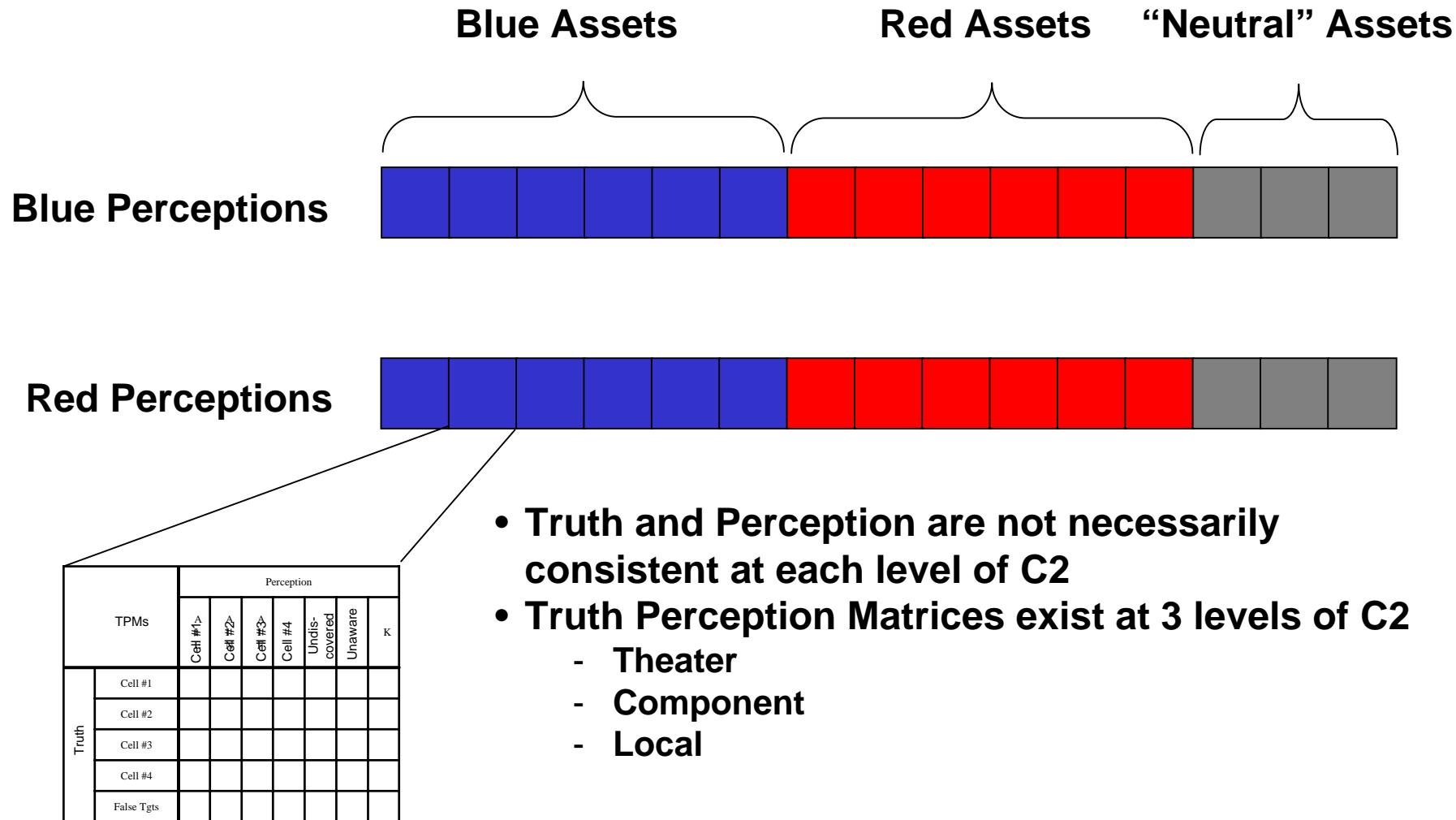


Sortie Rate Multiplier result with 20 out of 40 C2 nodes remaining

# Perception Based Planning

- **Truth-Perception Awareness Matrices (TPAM) relate truth and perception for each asset type in each cell for each side.**
  - Cell location, kill state, ID-ness, and movement states are assumed to be “mostly independent”.
  - Target states are tracked as distributions for target aggregates within a location cell.
- **Perception is used to accomplish all planning functions.**
- **Truth determines operational outcomes**
- **The TPAM has four components**
  - Cell Location Awareness Matrix (CLAM)
  - Location Awareness Matrix (LAM)
  - Kill Awareness Matrix (KAM)
  - Identification Friend or Foe Awareness Matrix (IDAM)

# Truth-Perception Awareness Matrices



# TPAM Structure

C2 LAM – Red Target 1

Perception

	$\Sigma$	C1	C2	Undiscovered	Un-aware
C1	5/3		1	1	1
C2	4/2	1		2	0
False Tgt	2	1	1	0	0
$\Sigma$		6/4	3/2	3	1

	Moving & Detected	Moving & Tracked w/ ID	Moving & Tracked w/o ID	Stopped & Imaged	Lost
Moving					1
Stopped					1
Hiding					1

C2 KAM – Red Target 1

	$\Sigma$	Alive	Indeterminate, Presumed Alive	Indeterminate, Presumed Dead	Dead
Alive	1	1	0	0	0
Dead	2	1	1	0	1

Off-diagonal Cell

C1/C2

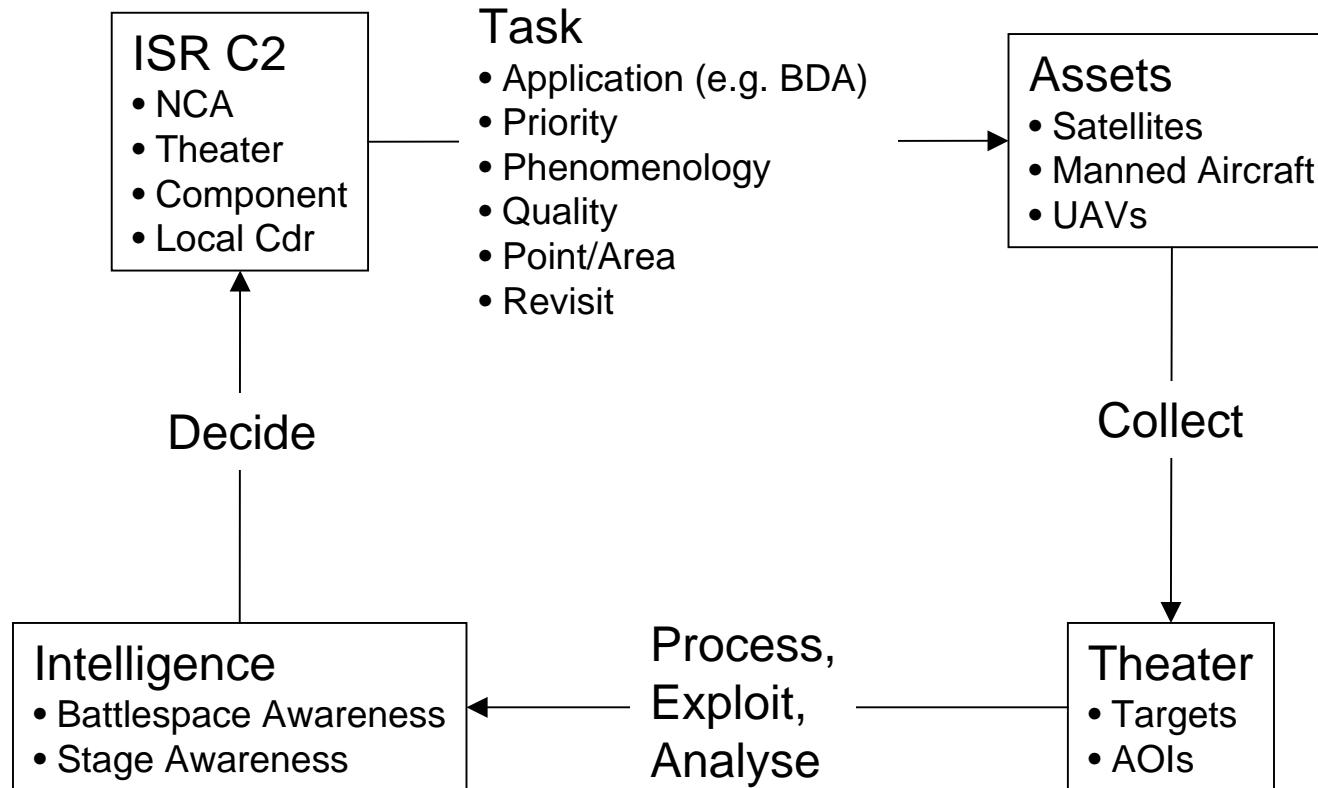
Red Target 1

	Count
Moving	0
Stopped	1
Hiding	0
Alive	1

Friendly				Neutral				Enemy				
Tgt1	Tgt2	...	TgtN	Tgt1	Tgt2	...	TgtN	Tgt1	Tgt2	...	TgtN	$\Sigma$
.05	.01	...	0	.01	.01	...	0	.7	.05	...	.01	1.00

KAM, LAM and IDAM are only defined “on the diagonal”

# ISR Modeling Overview



# ISR Tasks and Characteristics

- **ISR Tasks**
  - Prestrike - collect image of fixed target before striking from air
  - Battle Damage Assessment (BDA) - assess target health after striking from air
  - Mobile Target Reconnaissance – search for lost targets and confirm location/identity of previously located targets
  - Area Reconnaissance – search for undiscovered mobile targets
  - Area Surveillance – monitor known areas of interest with imagery
  - Monitor Mobile Targets- monitor known areas of interest with SMTI
  - Tracking – maintain location of target while it is moving with SMTI
- **Priority**
  - 1, 2, 3
- **Phenomenology/Quality**
  - EO/IR; Low, Med, High
  - SAR; Low, Med, High
  - SMTI (w/ or w/out ID)
- **Image Size**
  - Point
  - Area
- **Revisit Rate**

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